In the Claims

Please amend the claims as follows:

Claim 1 (cancelled herein)

Claim 2 (currently amended): The micro-electro-mechanical optical apparatus of Claim [[1]] 6 wherein the optical element is constructed of single crystal silicon.

Claim 3 (previously canceled)

Claim 4 (currently amended): The micro-electro-mechanical optical apparatus of Claim [[1]] 6 wherein said damping element comprises a damping means.

Claim 5 (currently amended): The micro-electro-mechanical optical apparatus of Claim [[1]] 6 wherein said damping element comprises a coating of a damping agent applied to the serpentine hinges.

Claim 6 (previously amended): A micro-electro-mechanical optical apparatus comprising:

an optical element capable of motion in at least one degree of freedom wherein the motion in the at least one degree of freedom is enabled by serpentine hinges configured to enable the optical element to move in the at least one degree of freedom;

driving elements configured to deflect the optical element in said at least one degree of freedom to controllably induce deflection in the optical element; and

damping element;

wherein said damping element comprises the serpentine hinges configured to reduce a magnitude of resonances.

Claim 7 (currently amended): A micro-electro-mechanical optical apparatus as in Claim [[1]] 6 wherein the optical element includes at least one reflective surface.

Claim 8 (currently amended): A reflector array comprising a plurality of micro-electro-mechanical optical apparatus as described in Claim [[2]] 6.

Claim 9 (currently cancelled)

Claim 10 (currently amended): A micro-electro-mechanical optical apparatus as in Claim [[1]] 6 wherein the optical apparatus is incorporated into a wavelength router having an optical cross-connect switch and a wavelength division multiplexer.

Claim 11 (currently cancelled)

Claim 12 (previously canceled)

Claim 13-15 (currently cancelled)

Claim 16 (currently amended): ~~A micro-electro-mechanical optical apparatus as in Claim 11~~ A micro-electro-mechanical optical apparatus comprising:

a support structure having a plurality of optical device assemblies formed thereon, wherein the optical device assemblies include:

a movable optical element having an outside edge joined to the support structure using a pair of serpentine hinges;

driving elements positioned such that activation of the driving elements can controllably induce deflection in the movable optical element; and

a damping element;

wherein the serpentine hinges comprise at least one winding with each winding having two arms; and

wherein the movable optical element is formed in a material layer having a layer thickness and the pair of serpentine hinges are formed in the layer;

wherein the movable optical element is selected from a group consisting of filters, blockers, gratings and lenses.

Claim 17 (currently amended): A micro-electro-mechanical optical apparatus as in Claim [[15]] 16 wherein the damping element comprises a damping agent means.

Claim 18 (currently amended): A micro-electro-mechanical optical apparatus as in Claim [[15]] 16 wherein the damping element comprises a layer of a damping agent formed on the pair of serpentine hinges.

Claim 19 (original): A micro-electro-mechanical optical apparatus as in Claim 18 wherein the damping agent comprises a polymeric material.

Claim 20 (previously cancelled)

Claim 21 (currently cancelled)

Claim 22 (previously amended): A micro-electro-mechanical optical apparatus comprising:

a support structure having a plurality of optical device assemblies formed thereon, wherein the optical device assemblies include:

a movable optical element having an outside edge joined to the support structure using a pair of serpentine hinges, wherein the serpentine hinges comprise at least one arm; and

driving elements positioned such that activation of the driving elements can controllably induce deflection in the movable optical element;

wherein each arm of each winding of each serpentine hinge extends in a direction transverse to the axis of rotation defined by the pair of serpentine hinges and wherein each arm is generally contoured to coincide with the shape of the outside edge of the mirror thereby defining circumferentially curved serpentine hinges.

Claim 23 (currently amended): A micro-electro-mechanical optical apparatus as in Claim 22 ~~11 wherein the serpentine hinges comprise at least one winding with each winding~~

~~having two arms and~~ wherein a proximal portion of each arm of each winding of each serpentine hinge includes a proximal fold which shapes the proximal portion of each arm such that it extends in a direction substantially parallel to an axis of rotation defined by the pair of serpentine hinges.

Claim 24 (previously amended): ~~A micro-electro-mechanical optical apparatus as in Claim 11~~ A micro-electro-mechanical optical apparatus comprising:

a support structure having a plurality of optical device assemblies formed thereon, wherein the optical device assemblies include:

a movable optical element having an outside edge joined to the support structure using a pair of serpentine hinges;

driving elements positioned such that activation of the driving elements can controllably induce deflection in the movable optical element; and

a damping element;

wherein the serpentine hinges comprise at least one winding with each winding having two arms; and

wherein the movable optical element is formed in a material layer having a layer thickness and the pair of serpentine hinges are formed in the layer;

wherein the shape of the pair of serpentine hinges comprises the damping element.

Claim 25 (previously amended): A micro-electro-mechanical optical apparatus comprising:

a support structure having a plurality of optical device assemblies formed thereon, wherein each of the optical device assemblies includes:

a movable optical element having an outside edge joined to the support structure using a pair of serpentine hinges; and

driving elements positioned such that activation of the driving elements can controllably induce deflection in the movable optical element; wherein each of the serpentine hinges further

wherein each of the serpentine hinges further comprises:

at least one winding with each winding having two arms with each winding having a length;

one end of each serpentine hinge is connected to the movable optical element and another end of the serpentine hinge is connected to the support structure; and

the length of each winding becomes progressively shorter from the one end of each serpentine hinge to the another end of each serpentine hinge.

Claim 26 (previously amended): ~~A micro-electro-mechanical optical apparatus comprising:~~

~~a support structure having a plurality of optical device assemblies formed thereon, wherein each of the optical device assemblies includes:~~

~~a movable optical element having an outside edge joined to the support structure using a pair of serpentine hinges; and~~

~~driving elements positioned such that activation of the driving elements can controllably induce deflection in the movable optical element;~~

~~wherein each of the serpentine hinges further comprises:~~

~~at least one winding with each winding having two arms with each winding having a length;~~

~~one end of each serpentine hinge is connected to the movable optical element and another end of the serpentine hinge is connected to the support structure; and~~

A micro-electro-mechanical optical apparatus as in claim 24, wherein each of the serpentine hinges includes first and second ends, and wherein the length of each winding becomes progressively longer from the [[one]] first end of each serpentine hinge to the ~~another~~ second end of each serpentine hinge.

Claim 27 (currently cancelled): A micro-electro-mechanical optical apparatus comprising:

a support structure having a plurality of bi-axial optical device assemblies formed thereon, wherein the biaxial optical device assemblies include:

a movable frame element having an inside periphery and an outside periphery;

the outside periphery of the movable frame element joined to the support structure using a first pair of serpentine hinges, the first pair of serpentine hinges defining a first axis of rotation about which the movable frame element can rotate;

a movable optical element having an outside periphery;

the outside periphery of the movable optical element joined to the movable frame element using a second pair of serpentine hinges, the second pair of serpentine hinges defining a second axis of rotation about which the movable optical element can rotate;

frame driving elements positioned such that activation of the frame driving elements can controllably induce deflection in the movable frame element, said deflection inducing rotation of the movable optical element about the first axis of rotation defined by the first pair of serpentine hinges;

optical element driving elements positioned such that activation of the optical element driving elements can controllably induce deflection in the movable optical element, said deflection inducing rotation of the movable optical element about the second axis of rotation defined by the second pair of serpentine hinges; and

a damping element;

wherein the movable optical element is selected from a group consisting of filters, blockers, gratings and lenses.

Claim 28 (original): A plurality of micro-electro-mechanical

optical apparatuses as in Claim 27 wherein a plurality of bi-axial optical device assemblies are organized in a two dimensional MxN array of micro-electro-mechanical optical apparatuses.

Claim 29 (original): A micro-electro-mechanical optical apparatus as in Claim 27 wherein the first axis of rotation about which the movable frame element can rotate is transverse to the second axis of rotation about which the movable optical element can rotate.

Claim 30 (original): A micro-electro-mechanical optical apparatus as in Claim 27 wherein the first axis of rotation about which the movable frame element can rotate is at substantially right angle to the second axis of rotation about which the movable optical element can rotate.

Claim 31 (original): A micro-electro-mechanical optical apparatus as in Claim 27 wherein the movable optical element comprises a mirror having at least one reflective surface.

Claim 32 (currently cancelled)

Claim 33 (original): A micro-electro-mechanical optical apparatus as in Claim 31 wherein the damping element comprises a damping means.

Claim 34 (original): A micro-electro-mechanical optical apparatus as in Claim 31 wherein the damping element comprises a layer of a damping agent formed on at least one pair of the first and second pairs of serpentine hinges.

Claim 35 (original): A micro-electro-mechanical optical apparatus as in Claim 34 wherein the damping agent comprises a polymeric material.

Claim 36 (original): A micro-electro-mechanical optical

apparatus as in Claim 31 wherein each of the first and second pairs of serpentine hinges comprise at least one winding with each winding having two arms.

Claim 37 (original): A micro-electro-mechanical optical apparatus as in Claim 36 wherein each arm of each winding of each of the first pair of serpentine hinges extends in a direction transverse to the axis of rotation defined by the first pair of serpentine hinges, and

wherein each arm of each winding of each of the second pair of serpentine hinges extends in a direction transverse to the axis of rotation defined by the second pair of serpentine hinges.

Claim 38 (previously amended): A micro-electro-mechanical optical apparatus as in Claim 37 wherein each arm of each winding of each first serpentine hinge extends in a direction transverse to the axis of rotation defined by the first pair of serpentine hinges and wherein each arm of the first serpentine hinge is generally contoured to coincide with the shape of the outside periphery of the frame element; and

wherein each arm of each winding of each second serpentine hinge extends in a direction transverse to the axis of rotation defined by the second pair of serpentine hinges and wherein each arm of the second serpentine hinge is generally contoured to coincide with the shape of the outside periphery of the mirror.

Claim 39 (original): A micro-electro-mechanical optical apparatus as in Claim 31 wherein each pair of the first and second serpentine hinges comprise at least one winding with each winding having two arms and wherein a proximal portion of each arm of each winding of each serpentine hinge includes a proximal fold which shapes the proximal portion of each arm such that it extends in a direction substantially parallel to the axis of rotation defined by each pair of serpentine hinges.

Claim 40 (original): ~~A micro-electro-mechanical optical apparatus as in Claim 31~~ A micro-electro-mechanical optical apparatus comprising:

a support structure having a plurality of bi-axial optical device assemblies formed thereon, wherein the biaxial optical device assemblies include:

a movable frame element having an inside periphery and an outside periphery;

the outside periphery of the movable frame element joined to the support structure using a first pair of serpentine hinges, the first pair of serpentine hinges defining a first axis of rotation about which the movable frame element can rotate;

a movable optical element having an outside periphery;

the outside periphery of the movable optical element joined to the movable frame element using a second pair of serpentine hinges, the second pair of serpentine hinges defining a second axis of rotation about which the movable optical element can rotate;

frame driving elements positioned such that activation of the frame driving elements can controllably induce deflection in the movable frame element, said deflection inducing rotation of the movable optical element about the first axis of rotation defined by the first pair of serpentine hinges;

optical element driving elements positioned such that activation of the optical element driving elements can controllably induce deflection in the movable optical element, said deflection inducing rotation of the movable optical element about the second axis of rotation defined by the second pair of serpentine hinges; and

a damping element;

wherein the movable optical element comprises a mirror having at least one reflective surface and

wherein the shape of the pairs of the first and second serpentine hinges comprise the damping element.

Claim 41 (original): A micro-electro-mechanical optical

apparatus as in Claim 31 wherein each of the serpentine hinges further comprise:

the first pair of serpentine hinges comprising:

at least one winding with each winding having two arms with each winding having a length;

one end of each first serpentine hinge is connected to the frame element and another end of the serpentine hinge is connected to the support structure; and

the length of each winding becomes progressively shorter from the one end of each first serpentine hinge to the another end of each first serpentine hinge; and

the second pair of serpentine hinges comprising:

at least one winding with each winding having two arms with each winding having a length;

one end of each second serpentine hinge is connected to the frame element and another end of the serpentine hinge is connected to the movable optical element; and

the length of each winding becomes progressively shorter from the one end of each second serpentine hinge to the another end of each second serpentine hinge.

Claim 42 (original): A micro-electro-mechanical optical apparatus as in Claim 31 wherein each of the first and second serpentine hinges further comprise:

a first end and a second end;

at least one winding with each winding having two arms with each winding having a length; and

the length of each winding becomes progressively longer from the first end of each serpentine hinge to the second end of each serpentine hinge.

Claim 43 (original): A micro-electro-mechanical optical apparatus comprising:

a support structure having a plurality of bi-axial optical device assemblies formed thereon, wherein the bi-axial optical device assemblies include:

a first movable frame element having an inside periphery and an outside periphery;

a second movable frame element having an inside periphery and an outside periphery;

a third movable frame element having an inside periphery and an outside periphery;

a movable optical element having an outside periphery;

the outside periphery of the first movable frame element joined to the support structure using a first pair of serpentine hinges, the first pair of serpentine hinges defining a first axis of rotation about which the first movable frame element can rotate;

the outside periphery of the second movable frame element joined to the inside periphery of the first movable frame using a first pair of torsional hinges which defines a first torsional axis of rotation about which the second movable frame element can rotate, the first torsional axis of rotation is substantially parallel to the first axis of rotation about which the first movable frame element can rotate;

the outside periphery of the third movable frame element joined to the inside periphery of the second movable frame using a second pair of serpentine hinges which define a second axis of rotation about which the third movable frame element can rotate, the second axis of rotation being transverse to the first axis of rotation;

the outside periphery of the movable optical element joined to the third movable frame element using a second pair of torsional hinges which defines a second torsional axis of rotation about which the optical element can rotate, the second torsional axis of rotation is transverse to the first axis of rotation and to the first torsional axis of rotation;

first frame driving elements positioned such that activation of the first frame driving elements can

controllably induce deflection in the first movable frame element, said deflection inducing rotation of the first movable optical element about the first axis of rotation defined by the first pair of serpentine hinges;

second frame driving elements positioned such that activation of the second frame driving elements can controllably induce deflection in the second movable frame element, said deflection inducing rotation of the second movable optical element about the first torsional axis of rotation defined by the first pair of torsional hinges;

third frame driving elements positioned such that activation of the third frame driving elements can controllably induce deflection in the third movable frame element, said deflection inducing rotation of the third movable frame element about the second axis of rotation defined by the second pair of serpentine hinges;

optical element driving elements positioned such that activation of the optical element driving elements can controllably induce deflection in the movable optical element, said deflection inducing rotation of the movable optical element about the second torsional axis of rotation defined by the second pair of torsional hinges; and

a damping element.

Claim 44 (original): A micro-electro-mechanical optical apparatus as in Claim 43 wherein the movable optical element comprises a mirror having at least one reflective surface.

Claim 45 (original): A plurality of micro-electro-mechanical optical apparatuses as in Claim 44 wherein the plurality of micro-electro-mechanical optical apparatuses define reflector assemblies and wherein the reflector assemblies are organized in a two dimensional MxN reflector array.

Claim 46 (original): A micro-electro-mechanical optical apparatus as in Claim 43 wherein the movable optical element is selected from a group consisting of filters, blockers, gratings, and lenses.

Claim 47 (original): A micro-electro-mechanical optical apparatus as in Claim 44 wherein the damping element comprises a layer of a damping agent formed on at least one of the first and second pairs of serpentine hinges and first and second pairs of torsional hinges.

Claim 48 (original): A micro-electro-mechanical optical apparatus as in Claim 47 wherein the damping agent comprises a polymeric material.

Claim 49 (original): A micro-electro-mechanical optical apparatus as in Claim 44 wherein each of the first and second pairs of serpentine hinges comprise at least one winding with each winding having two arms.

Claim 50 (original): A micro-electro-mechanical optical apparatus as in Claim 49 wherein each arm of each winding of each of the first pair of serpentine hinges extends in a direction transverse to the axis of rotation defined by the first pair of serpentine hinges, and

wherein each arm of each winding of each of the second pair of serpentine hinges extends in a direction transverse to the axis of rotation defined by the second pair of serpentine hinges.

Claim 51 (currently amended): A micro-electro-mechanical optical apparatus as in Claim 50 wherein each arm of each winding of each first serpentine hinge extends in a direction transverse to the axis of rotation defined by the first pair of serpentine hinges and wherein each arm of the first serpentine hinge is generally contoured to coincide with the shape of the outside periphery of the <u>first</u> frame element; and

wherein each arm of each winding of each second

serpentine hinge extends in a direction transverse to the axis of rotation defined by the second pair of serpentine hinges and wherein each arm of the second serpentine hinge is generally contoured to coincide with the shape of the outside periphery of the mirror.

Claim 52-55 (currently cancelled)

Claim 56-68 (previously cancelled)

Claim 69 (currently amended): A MEMS actuator comprising:

a support structure;

a movable optical element;

a plurality of serpentine hinges extending between the movable optical element and the support structure, each serpentine hinge including a plurality of arms exhibiting a plurality of arm lengths;

wherein each hinge includes a first end connected to the support structure and a second end connected to the movable optical element, and wherein the arm lengths of each hinge become progressively longer from the first end to the second end.

Claim 70 (previously presented): The MEMS actuator of claim 69, wherein the arms are curved from a perspective normal to the optical element.

Claim 71 (previously presented): The MEMS actuator of claim 69, wherein each hinge includes a first end connected to the support structure and a second end connected to the movable optical element, and wherein the arm lengths of each hinge become progressively shorter from the first end to the second end.

Claim 72 (currently cancelled): The MEMS actuator of claim 69, wherein each hinge includes a first end connected to the support structure and a second end connected to the movable optical element, and wherein the arm lengths of each hinge become progressively longer from the first end to the second end.

Claim 73 (previously presented): The MEMS actuator of claim 69, wherein the hinges define at least one axis of rotation, and wherein at least one of the arms extends in parallel with the axis of rotation.